Although the C&G paper addressed its proposed solution to this relevant limitation, it failed to consider the **cause** of the delay which it seeks to minimize and therefore failed to provide relevant improvement over the current scheme. Its proposal to introduce an additional superstructure of fifteen "Deletion Zones" with up to 32 blackout messages works according to its text in the **HSD Decoder** paragraph of page 12:

> "If deletion is contained in the program attribute the (descrambler) processor would check only the deletion zone data related to its region. In this way no decoder would ever be required to process more than 32 blocks of deletion zone data and processing of deletion zone data would not exceed the few seconds that the current system requires."

While the C&G paper is correct in stating that once each modified decoder "knows" which of the fifteen regions it belongs to, it only needs to **check** the messages for that region, the fact is that it still needs to **wait** until its regions' blackout messages are **received** so as to be processed. The fifteen "deletion regions" and their corresponding 32 blackout zones have to be broadcast in their entirety. Although each modified descrambler ignores all other fourteen "deletion regions" in its processing, it still needs to wait and receive the cluster destined for its region before it determines the availability of the program.

Apparently, the C&G paper assumed erroneously that the cause of delay was processing or computation delay, whereas the delay stems from the **transmission cycle time of blackout messages.** Basic knowledge of microprocessor engineering and the order of magnitude of their instruction cycle times (microseconds) would clearly point to computation delays of no more than milliseconds or tens of milliseconds, and not seven seconds or more. The C&G paper did not provide any solution which explicitly shortens blackout message cycle times. Thus contrary to their representations, **they have made no showing that a factor of fifteen expansion in blackout capability is feasible** with the VideoCipher II system without incurring a factor of fifteen penalty in acquisition times for **all** subscribers tuning that channel in.

As indicated above, the critical factor which must be addressed is the control channel capacity available to blackout messages. These messages must originate from the control computer at the uplink site because it is the only system having the detailed program schedule and attribute database for that site. However, the data channel originating from that computer, which in turn is broadcast to all decoders, contains many other messages which need to be inserted into the scrambler's limited control channel capacity. Some of these messages are related to:[1,2]

Channel and Program Specific Messages:

- Current Program Key (encrypted under several Category Keys, and thus repeated)
- Next Program Key (encrypted under several Category Keys, and thus repeated)
- Current program name strings
- Next program name strings
- Time remaining for current program
- Current Program Attributes: Program Rating, blackout flag, IPPV mode, Program Cost, Audio mode
- Next Program Attributes: Program Rating, blackout flag, IPPV mode, Program Cost, Audio mode
- Tier Addressed Messages

CATV Specific Messages:

- CATV Monthly Category Keys to all CATV commercial descramblers. Both current month and next months Category Keys are uniquely addressed and encrypted under each Unit Key, specific secret to each commercial descrambler.
- CATV Tier Authorizations for current and next month.

As can be seen, the rate at which essentially all of the above messages are transmitted directly affects the speed with which a descrambler tuning in the channel can obtain the necessary information to acquire and decode the signal. A limited control channel capacity, carrying these messages as well as the DBS Category blackout messages, must be judiciously apportioned to allow rapid receipt of **all** attributes and data required for proper decoding of the scrambled video and audio information.

As can be easily seen from the above, the acquisition time can be excessive when applied to a significant number of the 450 possible regions, and there is no reasonable way to reduce this delay to an acceptable level using the VideoCipher II Plus.

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1 M. F. Medress, "Satellite Television Scrambling with VideoCipher", IEEE Trans. on Communications Technology, September 1985, p 82.

2 M. F. Medress, "How Will VideoCipher Affect the TVRO Picture?", TVRO Technology, October 1985, p 20.

5.0 Additional Considerations

5.1 Defeating Syndex

From a subscriber's viewpoint, implementation of a blackout is blatant censorship implemented to protect someone else's finances about which he may not care. It is therefore highly likely that many subscribers would attempt to defeat the Syndex protection. The non-technical method of giving wrong location information has already been examined. The purpose of this section is to raise the issue of **technical defeat** of the Syndex capabilities beyond the obvious tuning to unscrambled feeds of the protected programming.

The method proposed by the C&G paper to implement Syndex is to use the current VideoCipher blackout capability of up to 32 areas in their proposed "Phase I" implementation. A significant factor that the C&G paper overlooks is that extensive use of this feature, besides causing considerable inconvenience to the user as previously mentioned, will cause the blacked out subscribers to look for available means to defeat this capability. Infrequent blackouts for occasional sporting events are not as significant as recurring restrictions due to local stations' need for Syndex.

Common sense dictates that subscriber supplied location information cannot be cryptographically authenticated. Thus, the area exclusion list is transmitted by VideoCipher in the clear (unencrypted) and is quite vulnerable to alteration. It is technically a rather simple matter to locate the appropriate control signals within the transmitted bit-stream, modify or replace the appropriate variables, and even append the appropriate parity tail to allow parity check of the message and acceptance by the descrambler, totally independently of the encryption function of the VideoCipher unit. It appears possible to market such a device with the purpose of defeating the Syndex feature of the VideoCipher II without defeating the encryption process, which may be completely legal.

A person responding to an advertisement or other type of contact, for the purpose of Syndex disabling is a good candidate for a complete piracy modification. A person offering a possibly legitimate method to defeat Syndex could very easily suggest that **it would be much cheaper** for both him and the viewer **to simply defeat the entire encryption system** and do a full pirate modification on the receiver (as has already been done on the present units). Therefore, **Syndex would be a substantial incentive for pirate conversions.**

Another related issue is that with Syndex, physical tampering with the descrambler would no longer be compelling evidence of attempted piracy. A possibly very effective pirate defense would be that the person simply wanted to receive what he had paid to receive. The modification would then have been done to "justifiably" defeat the Syndex blackout rather than receive programs not paid for, thus rendering law enforcement evidence development tasks ever more difficult.

5.2 Program Substitution Feasibility

- The C&G paper does not show feasibility of program substitution capability for blackout in the HSD market.

An element related to program substitution is an established dedicated substitution channel to which blacked-out HSD subscribers would tune to as an alternative. The C&G paper suggests that this is feasible in the HSD market by employing a shared substitution channel dedicated to that function for that market. The C&G paper (p. 9, last paragraph) cites the establishment of an alternative CATV sports programming channel as evidence that "(t)he feasibility of this program substitution scheme is supported by a recent establishment of an alternative sports programming channel." While relying on CATV examples with services supporting tens of millions of subscribers, the C&G paper provides no evidence that this dedicated substitution channel scheme is economically and financially feasible for 200,000 to 400,000 subscriber services in the HSD market.

Section 4.4 of the C&G paper refers to equipment produced by Comband Technologies which allows two television signals to simultaneously occupy the same bandwidth. It suggests that this provides a means to offer program substitution for excluded areas. It does correctly note that this causes degradation in the signal quality and "would require future technical changes to later model VC-II series receivers." That is an understatement. The Comband system causes considerable degradation, and uses baseband signal processing and amplitude modulation rather than separate frequency modulated carriers (sometimes used for doubling-up in satellite transponders). If this technique were feasible, it would be used to reduce the cost of normal program distribution. However, the Syndex substitution problem would still be the same.

In conclusion, it should be noted that the concepts suggested by the C&G paper in connection with program substitution are borrowed from the CATV environment and **are not feasible in today's HSD market.**

5.3 Market Size

- The C&G paper provides misleading information on the relative penetration of VideoCipher Descramblers in the U.S. HSD market and the fraction of satellite television programs protected by VideoCipher, thereby grossly overstating the feasibility of descrambler oriented blackout Syndex enforcement schemes.

In stating that "...(w)ell over 1.5 million households in the United States are presently equipped with small (HSD TVRO)..." (p.1, first paragraph) and further stating that "GIC and its licensed manufacturers have produced well over 1.5 million VC-II decoders for installation at HSD equipped homes" (p. 2, second paragraph), the C&G paper creates the impression that essentially all HSD households are equipped with VideoCipher decoders. Reliable estimates indicate that there are some 2.5 million U.S. households equipped with HSD terminals[1] and that GIC or its licensees shipped a total of 1.4 million decoders.[2]

Although 1.4 million decoders were shipped, a large portion of these decoders are not, and will not be, installed in U.S. HSD households. Several hundred thousand consumer VideoCipher decoders are known to be installed in Canada, the Caribbean and Mexico. Formal testimony before the Canadian Radio and Television Commission indicates some 180,000 VideoCipher Descramblers in Canadian HSD households.[3] Furthermore, the total VideoCipher shipment number includes decoders in inventory (estimated 100,000), distribution pipeline (estimated 30,000-40,000), and repair. Therefore, no more than 1.1 million decoders are currently installed in U.S. HSD households, leaving some 1.4 million U.S. HSD equipped households without VideoCipher descramblers. Hence, **more than 50% of U.S. HSD households are not equipped with VideoCipher decoders**, a fact conveniently ignored by the C&G paper.

The immediate question that comes to mind is what satellite programming is being viewed by the 1.4 million "decoderless" HSD households who have invested between $1500 to $3000 in their satellite systems? By its statement that "HSD access to virtually all satellite-distributed programming is authorized by the VideoCipher II system produced by GIC" (p 1, 2nd paragraph), the C&G paper would, at the very least, place these 1.4 million consumers in the most wasteful and uninformed consumer category ever imagined. The obvious answer is that the C&G paper is wrong. Many satellite television feeds carrying entertainment and sports programming are available in clear transmission, not the least of which are the very syndicated television shows that are a subject of the instant proceedings.

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1 Estimates for total installed U.S. home TVRO dishes range from 2.2 million to 2.72 million: 2.22 million in "System Sales Trends", Satellite Retailer, September 1989, p 8) 2.5 million in "Satellite Dish Sales Through July 1989", TVRO Dealer, September 1989, p 7. 2.6 million in Paul Kagan's 'Marketing New Media', No. 77, August 21, 1989. 2.72 million in "Consumer Electronics U.S. Sales", EIA Consumer Electronics Group, June 1989, p 24.

2 GIC's comments in an FCC scrambling standards proceeding, 1989.

3 Testimony based on June 1988 figures of 150,000 VideoCipher units in Canada, projects that by August 1989 the numbers is between 174,000 to 186,000. Tee Comm testimony, June 1988. In Decision CRTC 88-774 released October 27, 1988.

Table 1 lists the top 10 syndicated shows as ranked by Arbitron in the recent May 1989 sweeps. Also shown in Table 1 are the satellite transponders and the times on which **all** of these shows may be accessed in the clear, without the need for a descrambler. Similar availability of most other syndicated shows in daily or weekly recurring feeds can be found in most satellite programming guides. One such published schedule (attached as Appendix B), called "Recurring Feeds", lists hundreds of programming slots regularly available to home dish viewers. By one estimate, these programs constitute 25% of all programs on satellite TV[1].

Table 1 Top 10 Syndicated Shows

Rank [2]	PROGRAM NAME	Producer or Distributor [1]	Markets [2]	Equiv. US Rating [2]	Syndex Rights [4]	Unscrambled Transponder [3]	Transmission Time (Pacific Time) [3]
1	Wheel of Fortune	King World Prod.	198	13.3	Yes	T1, 20	M-F, 9:30 a & 4:00 , Sun. 8:30 a
2	Jeopardy	King World Prod.	185	11.6	Yes	T1, 20	M-F, 10:00 a, Tue-Sat, 4:30 a
3	Opran Winfrey Show	King World Prod.	193	9.2	Yes	T1, 17	M-F, 7:00 a
						W4, 19	M-F, 1:00 p
4	Cosby Show	Viacom	177	8.9	No	T1, 16	M-F, 7:00 a
						T1, 5	M-F, 10:30 a
5	Donahue	Multimedia	193	6.1	Yes	T1, 18	M-F, 6:00 a
						T1, 1	M-F, 1:00 p
6	Entertainment Tonight	Paramount	143	5.7	Yes	T1, 9	M-F, 12:30 p
						F2, 3	M-F, 2:00 p
						F1, 1	M-F, 2:00 p
7	Cheers	Paramount	157	5.7	Yes	T1, 9	M-F, 11:30 a & Sat. 11:00 a
8	People's Court	Warner Bros. TV. Int.	168	5.4	N/A	T1, 3	M-F, 10:30 a & 6:00 p
						T1, 3	Sun. 6:00 a (5 Consecutive Shows)
9	A Current Affair	20 th Century Fox	137	5.3	Yes	T1, 21	M-F, 1:00 p
						T1, 23	M-F, 3:00 p
10	Family Feud	LBS Comm. Inc.	104	4.8	Yes	T1, 9	M-F, 8:00 a
						T1, 9	Sat. 7:00 p (5 Consecutive Shows)

Sources:

[1] Television Programming Source Book, 1989.

[2] Arbitron Ratings Co. Local May 1989 Sweeps. Report in "Electronic Media", July 3, 1989 (p6)

[3] "Recurring Feeds" in "Satellite TV Week" program guide ,Sept 4, 1989 (p16)

[4] "A Syndex Sampler", By Peggy Ziegler, in "Cable World" August 21, 1989 (p19); Also United Video's Syndex info.

N/A - Information not available

As seen in Table 1 and in Appendix B, unlike the scheduled broadcasts of some of these syndicated shows on local broadcasts or on satellite superstations (which may be scrambled), these clear transmissions, intended for delivery to local broadcasters for retransmission in their respective markets across the country, are available several times a day. They are even available on a consecutive sequence basis during the weekends for shows shown throughout the week, offering excellent opportunity for the home satellite viewer to tape the entire weekly installment or time-shift a favorite show. It becomes clear that, to both VideoCipher equipped and unequipped HSD households, these Recurring Feeds constitute better-valued syndicated programming delivery means

1 L. M. Fries, "Where the Wild Feeds Are", Satellite Orbit, June 1989, p 4.

than those available through scrambled superstations in the normal course of their daily programming.

No evidence has been presented in these proceedings that VideoCipher owners who subscribe to the scrambled superstations view their syndicated programs on said superstations and not on the above-mentioned unscrambled Recurring Feeds. Furthermore, there is no doubt that if Syndex blackouts were to be attempted through descrambler enforcement means, the scheme will not provide to the exclusive right holder any HSD enforcement capability, because **none** of the HSD users within his local market will be denied access to these programs on clear Recurring Feeds. Regardless of any legal issues which may surround the viewing of such signals, the fact remains that such HSD owners would,in the full face of Syndex, turn to these Recurring Feeds.

In conclusion, the objective determination of the feasibility of descrambler-based Syndex schemes cannot be made absent considerations of availability of such programs through other national satellite means. **The successful implementation of descrambler-based blackout schemes are infeasible unless the programming it intends to protect is scrambled on other nationally available feeds.**

5.4 Differences Between CATV and Satellite Syndex

Any broadly-based analysis should first determine the differences in feasibility criteria it should apply for both CATV and satellite technologies. In so doing, the following differences should be considered:

5.4.1 Blackout technique

Upon a valid notification by a Syndex right holder in his local market, the CATV operator at his discretion may effect a blackout of a CATV channel by disconnecting the video source carrying the protected programming from that channel's modulator, and by connecting an alternative video source for the duration of the blackout. The substitution source can either be a text message indicating blackout or alternative programming material, which would provide an advantage of masking the blackout effects. This blackout operation would take place **at the local market level**, without any interaction with other CATV markets.

Unlike this local CATV blackout, the satellite blackout technique must be national, **where a single channel is so processed so as to cause different effects on different decoders.** As described previously, the blackout control is effected in each decoder located in a blackout zone. The uplink operator does not have the ability to change his national channel video source, as he must continue to serve those who are not in blackout zones. Furthermore, due to the common broadcast nature of the control data channel containing blackout messages, his actions, which are designed to blackout some regions, **cause service degradation to other non blacked-out subscribers nationwide** due to increased channel access delays.

5.4.2 Administrative and Business Issues

Cable operators will only have to process blackout requests from their **local** broadcasters which may not be more than a handful. Their administration costs and database maintenance expenditures reflect only the limited activity in their local market. In contrast, the satellite operator's tasks are **national** by nature. He must deal with requests from every Syndex right holder across the country. This means that **every satellite operator would be administratively burdened with a recurring task equivalent to that suffered by the entire CATV industry and must bear the related costs!**

Although cable operators and local broadcasters who might seek Syndex protection in their local CATV system share the same market and thus have some mutual interests, the cable operators have more flexibility in reducing the impact of Syndex. They can negotiate flexible terms such as channel assignments and carriage terms. No such opportunity exists for the satellite operator.

As noted above, in many cable systems a blacked-out syndicated program on a distant imported channel will be available on another channel carrying a local broadcast. This situation is less likely to be found on satellite subscription.

It might be argued that cable subscribers with access to 30 to 50 channels and one or two channels blacked out, would perceive only a slight reduction of their subscription value. However, a significant number of HSD owners subscribe to program packages of only 3-5 channels. In some cases, **all of these channels might be subject to Syndex blackout** at various times, profoundly impacting the perceived value of the service and likely raising contract terminations.

6.0 Conclusion

The present design of the VideoCipher II descrambler does not allow handling the increased control traffic and complexities required by the implementation of Syndicated Exclusivity (Syndex) in the satellite broadcasting industry now or in the near future. It is simply not technically or economically feasible. The same is also true of the VideoCipher II Plus, the anti-piracy program presently in field trials.

The Cooperman and Gould paper, which supports the short-term implementation of Syndex, was shown to be based on cursory and erroneous information on the VideoCipher II, the proposed vehicle of implementation. Examination of even an optimistic project-plan schedule shows that the proposed C&G schedule is clearly impossible. The earliest implementation would be well more than a year later. Also, delay of the current anti-piracy program to allow implementation of Syndex could cause descrambler shortages which would have a disastrous impact on the satellite broadcasting industry.

The true cost to modify most of the VideoCipher units for Syndex would be in the vicinity of $250,000,000—for which subscribers would get a cut in service and would be saddled with unacceptable channel access delays. This would provide a strong incentive for "justifiable" piracy.

Syndex can be easily defeated by non-technical means. It can also be easily defeated by technical means which would encourage piracy, thereby defeating the very reason for existence of the VideoCipher units.

We therefore conclude that implementation of Syndex using VideoCipher II is neither technically or economically feasible and would unnecessarily cause considerable harm to the HSD industry.

Acknowledgments

The authors would like to thank Donald K. Dement who contributed in various ways toward the creation of this paper.

Appendix A Vitae

Dr. G. Gordon Apple - President, Advanced Communications Engineering, Inc. Dr. Apple received his BSEE degree from the University of Arkansas in 1966 and an MSEE and PhD from Purdue University in 1967 and 1970 respectively. He has over 25 years experience in digital communications spanning the telephone, computer, space, and defense industries. Dr. Apple has patents in the fields of error correction coding, digital transmission, synchronization, and video data compression. He also has various publications and has made many presentations (including internationally) on these subjects. Dr. Apple is a Senior Member of IEEE, a member of Sigma Xi (research society), Eta Kappa Nu, Tau Beta Pi, Pi Mu Epsilon, and the Society of Motion Picture and Television Engineers. He is a Registered Professional Engineer and an instrument rated pilot.

While at Purdue, Dr. Apple developed a transform-coding digital filter for NASA on a research contract. He then worked at Bell Telephone Laboratories on digital-interframe-coding video-compression techniques for PicturePhone® transmission. At North Electric he headed up a department which developed transmission, synchronization and multiplexing systems for a new digital telephone switching system. He then was Director of Engineering for Automation Products Company. At TRW, Dr. Apple was involved in and did project management for many digital communication system projects including satellites, modems, and data compression systems. He served as system engineer on the Space Shuttle's primary communications system (for which he received award recognition from NASA) and served as system engineer on a number of satellite programs including Mod-35, TDRSS, OMV (Orbiting Maneuverable Vehicle) and classified programs. He more recently served as the C-band system engineer on the Intelsat VII proposal, partly in Tolouse, France, jointly with MATRA.

Dr. Apple was a system engineer for development of a secure-voice terminal (for Ft. Meade) and developed the KDC (Key Distribution Center) protocols and signal formats used for exchanging crypto-keys in this system. He was the system engineer for the project that developed the television satellite transmission scrambling system that was TRW's entry into this field in competition with the (winning) VideoCipher scrambling system.

Dr. Apple was principal investigator and project manager for a joint effort with CBS Television to develop data compression for High Definition Television (HDTV) using digital transmission via Direct Broadcast Satellites. He also served as assistant Program Manager for VHSIC (Very High Speed Integrated Circuit) ground terminals for the MILSTAR satellite system—by far the most sophisticated communications satellite ever built. This was a pioneering program which was the first to incorporate the most powerful and advanced digital-signal-processor ever designed. He was then principle investigator for IRAD (Internal Research and Development) programs for small, light-weight EHF (Extremely High Frequency) terminals. He developed a system design for an ultra-small VHSIC Phase II (wafer-scale integrated circuit) EHF satellite communications terminal[1] and proposed (to NSA) a unified cryptographic integrated circuit design for use by the Air Force.

In recent years Dr. Apple has devoted his efforts toward concept development, system design, and promotion of digital transmission for DBS broadcasting of television, HDTV, educational services (e.g., the YES Networks), and other services. In particular, he pioneered the concept of using personal computers to (digitally) broadcast services directly to televisions and personal computers. He has also been actively engaged in extending the concept of "object-oriented computer programming" across boundaries between multiple diverse processors and dedicated hardware, particularly between personal computers and embedded signal processors.

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Dr. Ron D. Katznelson - President, Multichannel Communications Sciences, a San Diego based firm founded in 1989 for developing and offering broad technical, technological and strategic assistance with emphasis on signal processing and telecommunications systems. Dr. Katznelson has over 20 years of experience in communication systems and electronics related technologies. Dr. Katznelson holds a BS dual degree in Mathematics and Physics, MSc. degree in Solid State Physics —both from the Hebrew University in Jerusalem and a PhD degree in Electrical Engineering (Communication Theory and Systems) from the University of California (UCSD). He has co-authored a book and authored numerous technical publications in various areas ranging from semiconductor device physics, signal processing, satellite television transmission techniques to publications on HDTV and EDTV transmission systems. Dr. Katznelson holds several patents and patent applications in the areas of television encryption, digital audio compression and transmission, video processing and EDTV systems.

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1 Presented at MILCOM, 1987, Monterey, CA.

Prior to his present position, Dr. Katznelson was with the VideoCipher Division of General Instrument, where he served as Director, New Technology development. He joined General Instrument Corp. (GIC) as part of the acquisition of the VideoCipher Division from M/A-COM Linkabit in 1986 by GIC. Dr. Katznelson Joined Linkabit in 1983, where he worked on design and development of various satellite communications systems and later contributed to the development of the VideoCipher(R) II system and served as the system engineer for the terrestrial version of that system. While at Linkabit, as an Engineering Manager, Dr. Katznelson had considerable experience in development projects and engineering management.

Prior to his position at M/A-COM Linkabit, Dr. Katznelson was a full time Assistant Professor of Electrical Engineering at the Electrical Engineering and Computer Science Department of the University of California at San Diego (UCSD). There he was engaged in academic research in signal design for parameter estimation and detection as well as teaching electrical engineering courses.

Prior to his academic professional activity, Dr. Katznelson held a project engineering position in Moked Engineering, an electro-optics development and manufacturing firm in Jerusalem, Israel, where he was responsible for developing a laser based military optical communications system as well as infrared warning systems for military applications. His military service before and during the 1973 Middle-East War involved Communications and Electronic Warfare system definition and development in the Israel Defense Forces.

Dr. Katznelson is a licensed Amateur Radio operator since 1967 and a licensed private pilot since 1979.

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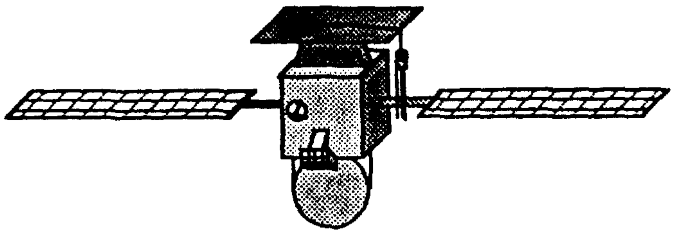
Appendix B



August 21, 1989

Digital Broadcasting:

Bringing the Future of Education to Rural America Today

By: G. Gordon Apple, PhD

The Partners:

The Foundation for Educational Advancement Today (FEAT)
Advanced Communications Engineering, Inc. (ACE)
YES Networks, Inc. (Your Educational Services)

The Advisors:

The National Aeronautics and Space Administration
The National Education Association
The American Federation of Teachers
The American Association of School Administrators
National School Board Associations' Institute for the Transfer of Technology to Education
Advanced Communications Corporation (ACC)

Acknowledgements:

The author would like to thank Dan Garner, Toby Coe, Kay Goss, and especially Don Dement for their suggestions, contributions, reviews and discussions relative to this paper.

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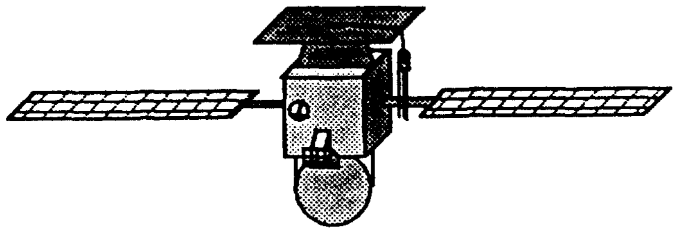

Abstract

A new dawn is about to break in rural America. The entire country will be illuminated with a variety of new broadcast services, some being so innovative that no counterpart now exists with which to compare. High-quality standard-television and digital radio stations will be provided, along with a natural path toward compatible HDTV (High Definition Television). **Sophisticated educational and data services (including training and seminars) will be readily available to schools, homes, hospitals, doctor's offices and small businesses in rural America.** ACC's **Digital DBS** (Direct Broadcast Satellites, received with two-foot-diameter antennas) and ACE's engineering innovations will make these services possible.

Initially, **educational services** (through FEAT's underwritten YES Networks) **will benefit the most** due to increasing transmission efficiencies, minimizing cost and allowing new capabilities not previously possible technically or feasible economically. Depending on the service mix, **40 to 400** or more courses can be simultaneously delivered by the YES Networks system compared to one or two courses with today's analog transmission. Digital technology and nationwide distribution will allow trial and implementation of innovative educational concepts such as student educational incentive programs.

ACC is donating two DBS transponders to FEAT, which, in turn, plans to provide transmission capacity and receivers (approx. $400 MM) for nationwide school coverage by the YES Networks. A prerequisite is that the system design be refined so that mass production of receivers is feasible and service trials can be implemented and evaluated. A program is described which will accomplish this and permit rural America to be the **first** beneficiary of this innovative broadcast technology.

TABLE OF CONTENTS

FIGURES

Background

Rural Development and DBS

When REA (Rural Electrification Administration) originally was established, its purpose was to finance the construction of an electric power distribution system to the rural homes and smaller communities of America, which otherwise were being left out in the rush toward urban electrification. Subsequently, rural telephone service was promoted and supported. Although REA's original charter is now largely fulfilled, **rural America has new needs**, especially in education, **and is again in danger of being slighted** by the new communications technology revolution which is taking place in urban areas.

It is time for rural America to have equal access to the same high-quality television, stereo-radio, educational, and data services enjoyed by the urban communities and not be left out in a rush to high-definition television and other new services. The only reasonable hope of doing this is through Direct Broadcast Satellites (DBS), i.e., high-power signals sent directly to inexpensive receivers. The DBS receiver needs only a two-foot diameter dish antenna that is considerably easier to install than a conventional television antenna, and can be set-up by nearly anyone.

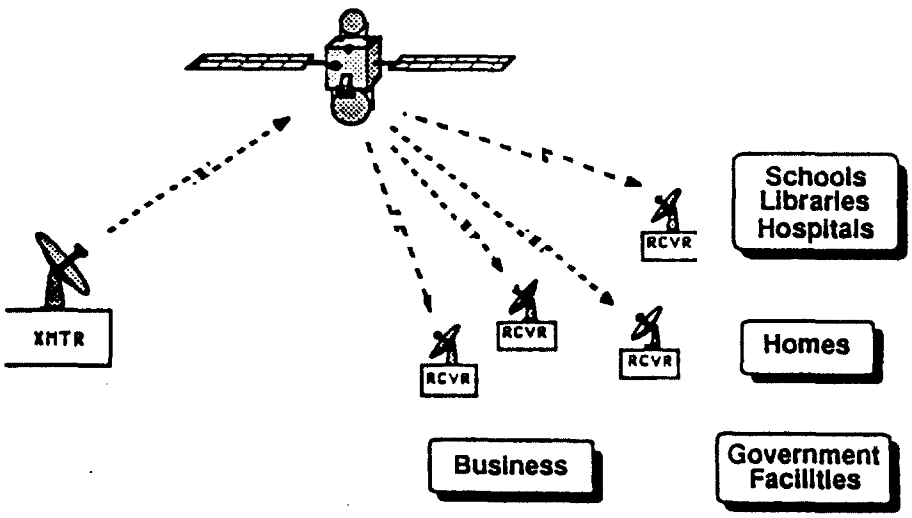

Figure 1.1 Direct Broadcast Satellites

ACC's Digital DBS

The broadcasting system described here is unlike anything that exists today. It is transmitted by a digital bit stream, unlike the analog systems that now exist. Digital DBS can bring a multitude of much needed educational services directly to rural America's schools and homes long before such services will even be available by means of fiber optics in the larger metropolitan areas.

This is a technological advancement that would not have been commercially feasible five or ten years ago. Now, it is not only feasible, but it is the logical choice for HDTV, educational broadcasting, and a multitude of other new services. Its impact on several basic industries will be revolutionary, and most importantly, **it is the ideal medium for bringing quality educational and other broadcasts services to the rural communities of America.**

Advanced Communications Corporation (ACC) is one of only three current FCC permit-holders now legally permitted to construct a direct broadcast satellite (DBS) system having suitable orbital locations. This is a new broadcast service using satellites designed for the smallest terminals. ACC has been approved to operate at least 27 television or data transponders, covering the entire U.S.

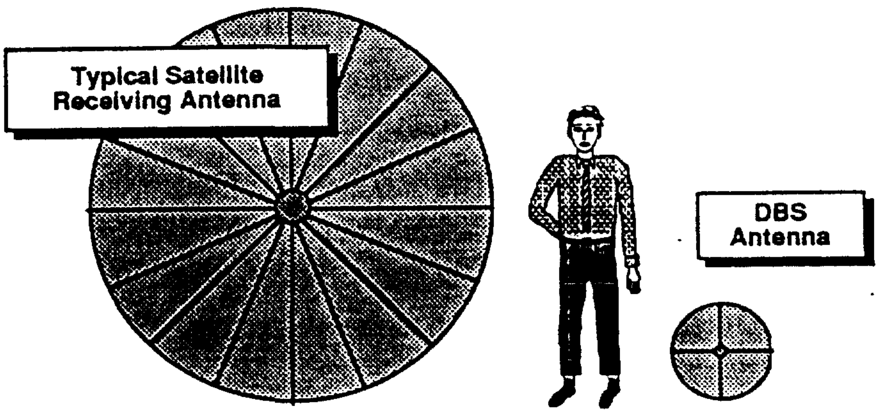

Figure 1.2 Antenna Size Comparison

DBS was originally envisaged as a **television** broadcasting service to homes with receiving antennas of less than one meter diameter. The FCC wisely has **not** mandated the form of the transmitted signal or its service content. Of the DBS Permittees, ACC **has taken the technological leadership position** and is the only permittee fully embracing digital technology and transmission–the same technology which revolutionized audio recording and made personal computers possible **Only ACC's system** combines the smallest-terminal convenience and simultaneously **fulfills numerous other user needs** besides entertainment television.

Examples of ACC's DBS Goals

Digital transmission will allow ACC to offer to all areas of the nation not only the best cable-like standard television service but also:

Economical, innovative educational services (K-12, university, professional, adult);

Data services (e.g., detailed weather, markets, customized news coverage);

CD-quality digital radio stations (vastly superior to FM);

A natural pathway toward compatible high-definition television (HDTV).

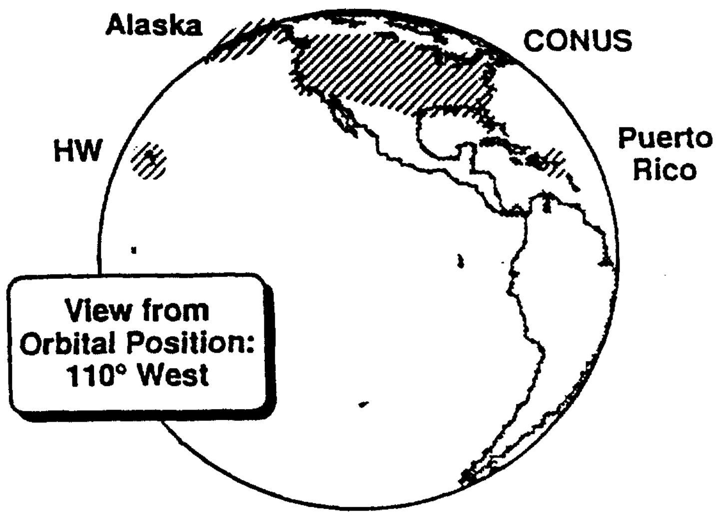

Figure 1.3 Orbital View of Coverage Area

This technology is the culmination of advances developed over the last 20 years at Bell Telephone Laboratories, TRW, CBS, NASA, Advanced Communication Engineering (ACE, an affiliate of ACC), and many others. The continuing advancements in receiver and integrated circuit technology and in personal computer hardware and software make these services feasible now, and make this system an obvious choice for the future.

Educational Services

It is no accident that the first uses of satellites for distance-learning have been in some of the most technologically underdeveloped countries (e.g., China, India, Indonesia) in spite of the costs of user terminals for low-power satellite transmissions. Satellite broadcasts encounter few physical, political or urban-access barriers. This use of high technology is allowing these "low-tech" countries to leap-frog into modern-day science, medicine, agriculture and technology, where conventional means would have taken generations to achieve a similar level of educational penetration.

It is also no accident that, in the U.S., one can see more satellite receiver dishes in rural areas than anywhere else. Many rural areas are not sufficiently served by television, FM radio, cable systems, or data services. Cable, whether wire or optical, is only a dream in these areas because of the inherently high cost for long distances and low density of distribution taps. In addition, school teachers, **particularly in the critical areas of math and science**, are difficult to acquire, so that quality education is difficult or non-existent without unacceptably long commutes by students and teachers.

In order to fill the shortage of rural teachers, numerous "distance-learning" methods have been attempted-- some by satellite, some by telephone lines and other techniques-- some successful, some not. Current satellite educational video transmission is generally expensive. It takes the same satellite capacity (one transponder) for one video lecture to one classroom as to distribute a television program to millions of people. As a result, some of today's distance learning is possible only with government operating funds.

To avoid the high cost of leasing an entire satellite transponder, various alternatives have been tried, such as electronic blackboards using telephone lines, expensive video compression equipment (originally designed for business conferencing), and interleaving and capturing of still-video television frames. While these techniques can be effective, they are either limited in capability or require high capital expenditures for terminal equipment. Most users of distance learning also have a need to transmit other information such as reading materials, homework assignments, and exams.

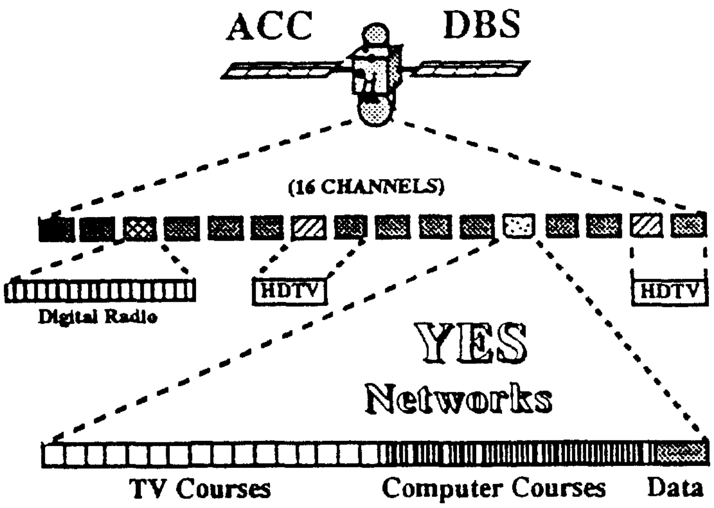

Figure 1.4 Satellite Channelization

The **YES (Your Educational Services) Networks'** all-digital educational broadcasting system provides extremely efficient solutions for all of these needs. Using a single DBS transponder, a complete spectrum of educational services will be offered to schools, homes and businesses, using techniques ranging from still-frames (plus voice) to moderate-motion video. A new factor is the ability today to use a personal computer to easily generate highly stimulating presentations which can be transmitted directly to television receivers or to classroom computers, the latter being much more efficient and versatile.

Depending on the particular mix of services, present estimates are that the **YES Networks** can simultaneously carry anywhere from **40 to 400** or more individual courses where only one is possible by conventional techniques. In addition, the ability to inexpensively "download" (send data from the central source to the user) support materials for the courses and implement innovative educational techniques and programs is an inherent part of this uniquely flexible system.

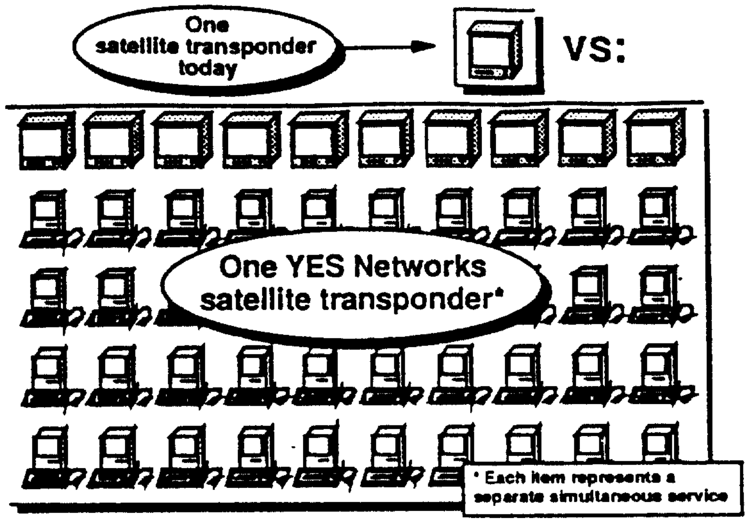

Figure 1.5 Comparison of Services

ACC, FEAT and YES Networks

ACC has agreed to contribute the use of two transponders for the duration of their useful lifetime, expected to be 12+ years, to FEAT for implementation of educational broadcasting. In addition, the Foundation for Educational Advancement Today (FEAT) is planning a program to provide one satellite receiver to every school, hospital, and library in the country.

However, the necessary equipment first must be developed for field-testing in schools, and then for implementation with integrated circuits for economical mass production. Toward this end, preliminary project planning with scheduling is included later in this paper.

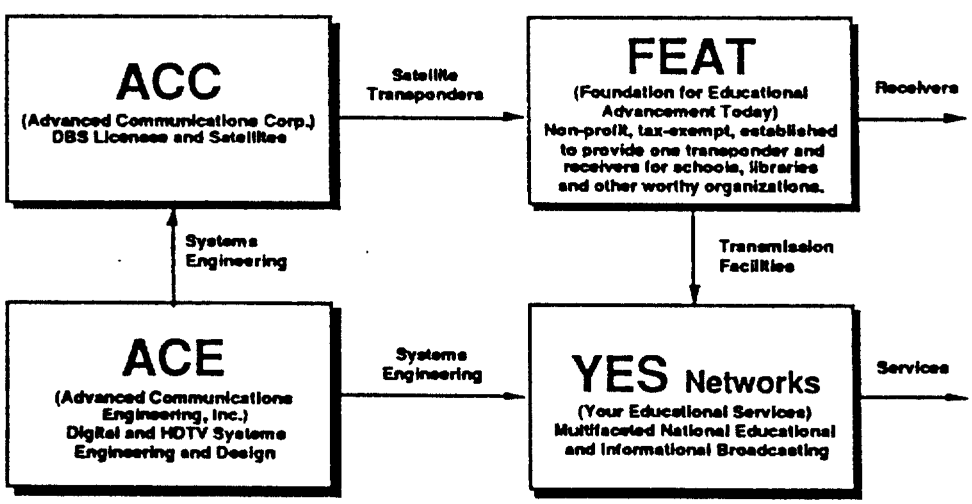

Figure 1.6 Organizations Involved

Project Description

Only truly innovative means can assure the continued advance of American education to meet the challenges facing students in the 1990's and beyond. Creative solutions will not be developed and implemented overnight, but must be found, tested, and introduced as efficiently and effectively as possible. A demonstration and test period for a dramatic new application of technology is described, developing an educational telecommunications network that can yield extraordinary benefits for rural students and teachers in the very near future.

Three basic services types are illustrated in Figure 2.1. One is a **TV Course** service which is functionally similar to that being offered today, but is far more transmission efficient, far less expensive, and has the flexibility of including additional services such as printed output . The second is a **Computer Course** service which is considerably more efficient and less expensive than the TV courses, but can still be displayed on television receivers.

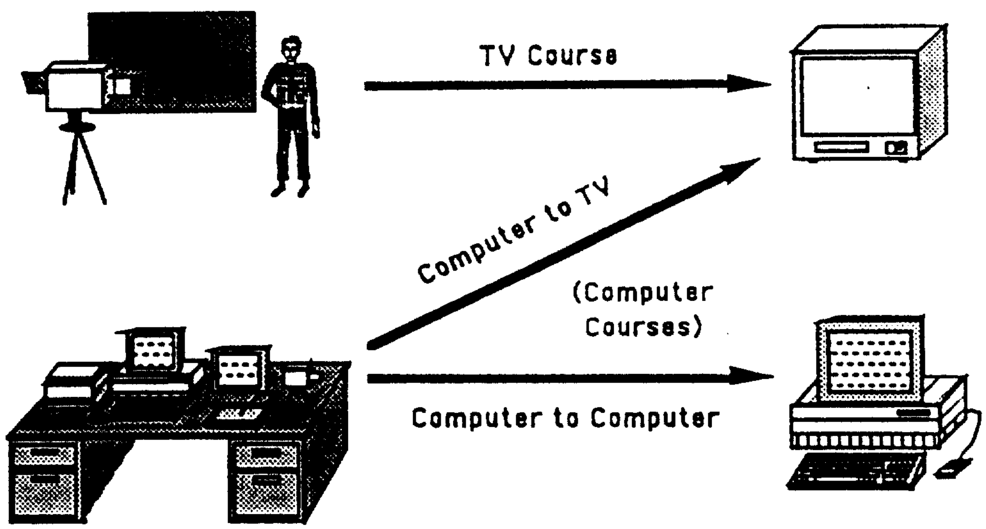

Figure 2.1 Service Categories

The third is another type of **Computer Course** service which is even more efficient and less expensive to transmit than the other courses, but utilizes a personal computer with a monitor or an overhead projector using a computer adapter. This method of course transmission has vast additional capabilities that cannot be offered by any of today's TV course transmissions. A substantial number of these services can be offered simultaneously by the **YES Networks** within one satellite transponder.

For the Computer Courses, the computer will be used in creating materials for the course, originating the course broadcasts, presentation of the course broadcasts, dissemination of materials for use on other computers, interactive on- and off-line individual study, and a multitude of other innovative ways that we can only speculate about at present. The entire process will automatically instill a level of comfort and familiarity with computer techniques in both teachers and students which would otherwise be difficult or impossible to attain.

Preliminary work has been described in a proposal[1] and final report[2] for an ACE contract with NASA and the PSSC[3], in which ACE examined the utility of a new technology in satellites (ACTS[4]) for educational broadcasting.

More detailed descriptions of these educational broadcast services are included in Appendix A.

Objectives

The primary objectives of the project are as follows:

- Demonstrate highly innovative low-transmission-cost distance learning techniques using compressed television and personal computers;
- Demonstrate the viability, ease of use, and effectiveness of personal-computer-based educational broadcasting, especially for mathematics and science instruction;
- Foster awareness and understanding of the merits of digital-based educational broadcasting as a tool for distributing instruction, teacher training, and materials;
- Develop initial plans for student and teacher incentive programs.
- Refine the system to a point ready for mass production of the school receivers.

The Needs

Needs Addressed by the Project

The primary need is to **improve access of rural school students to mathematics and science instructional materials** which now are available only to districts with superior resources. The project will demonstrate how, by greatly reducing costs to acquire and disseminate, this synergistic technology combination will expand access to a variety of new and improved educational.materials and unusual resources to students, exposing them to **master teachers** recognized nationally for their instructional excellence.

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1 Advanced Communications Engineering, Inc., *Proposal to the Public Satellite Service Consortium and NASA ACTS Program*, October 21, 1987.

2 Advanced Communications Engineering, Inc., *Final Report: ACTS Educational Broadcasting*, Submitted to the NASA ACTS Program and Public Service Satellite Consortium, April 30, 1988.

3 Public Service Satellite Consortium.

4 Advanced Communications Technology Satellite, an experimental digital transmission satellite operating at K_a -band (20-30 GHz).